Travis County FY2013
Jollyville Plateau Salamander (*Eurycea tonkawae*)
Monitoring Report

Photo: *Jollyville Plateau salamander* Piers Hendrie, Spring 2008

Travis County
Department of Transportation and Natural Resources
Natural Resources and Environmental Quality Division

October 1, 2012 – September 30, 2013

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Background

On May 2, 1996, the City of Austin and Travis County were jointly issued a U.S. Fish and Wildlife Service (USFWS) regional permit referred to as the Balcones Canyonlands Conservation Plan (BCCP). This permit allows "incidental take" of eight locally occurring endangered species in compliance with Section 10(a) 1(b) of the Endangered Species Act (U. S. Fish and Wildlife Service 1996a). The thirty-year permit covers approximately 561,000 acres in western Travis County, Texas identified in the Habitat Conservation Plan and Final Environmental Impact Statement (HCP) (U. S. Fish and Wildlife Service 1996b). The permit also covers incidental take of 27 species of concern should any become listed as threatened or endangered during the life of the permit.

Under the terms of the permit, the City of Austin and Travis County established the Balcones Canyonlands Preserve (BCP) to set aside and manage a minimum of 30,428 acres of habitat for two endangered bird species, the golden-cheeked warbler (*Setophaga chrysoparia*) and black-capped vireo (*Vireo atricapilla*), and six endangered karst species. The permit holders also agreed to manage twenty-seven species of concern that include populations of two rare plants, Texabama croton (*Croton alabamensis* var. *texensis*) and canyon mock-orange (*Philadelphus ernestii*), and a suite of unique invertebrates located in a total of 62 karst features.

The Jollyville Plateau salamander (JPS) (*Eurycea tonkawae*) occurs within the BCP and the overall management of Travis County preserve lands benefits the conservation of this species. Although the BCCP 10(a) permit does not cover "take" of this species or require mitigation, the BCCP partners have pledged to protect the species wherever it is located within the BCP.

On September 19, 2013, the U.S. Fish and Wildlife Service listed the JPS as threatened (U. S. Fish and Wildlife Service 2012) under the Endangered Species Act and designated thirty-two units of critical habitat (total 4,331 acres) in portions of Travis and Williamson Counties (Figure 1). The most significant threat is degradation of aquatic habitats, primarily in the form of reduced water quality and alteration of natural flow regimes (USFWS 2013). The degradation is a result of rapid human population growth and urbanization within the small range of the JPS. About half of the total area within stream catchments within the JPS range has been developed. In areas with the largest residential development, there has been decline in relative abundance of JPS. Urbanization has a strong negative effect on density of JPS across its range (Bendik *in press*).

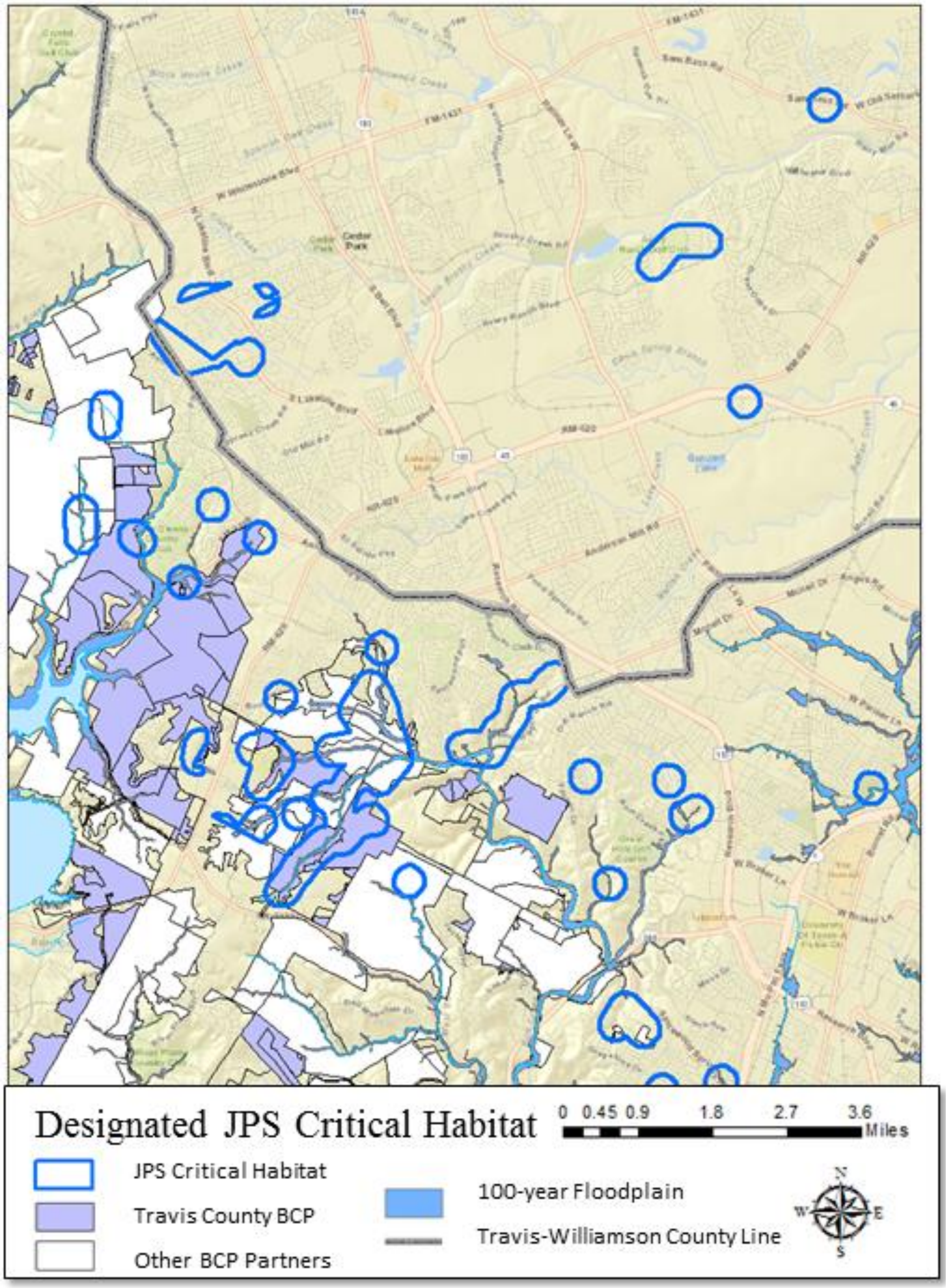


Figure 1. Critical Habitat Units designated for the Jollyville Plateau salamander in northwestern Travis and southern Williamson Counties. Surface critical habitat includes the spring outlet up to the high water line and 164-feet (50 m) downstream. Subsurface critical habitat includes a 984-foot (300 m) radius surrounding each spring.

Life History of JPS

JPS is an aquatic salamander that is endemic to surface and subsurface groundwater dominated habitats in northwestern Travis and southern Williamson counties. It is entirely aquatic; it does not transform into a terrestrial form (neotenic) and retains its feathery gills (perennibrachiate) throughout its life. It is a member of the Plethodontidae, a large family in the order Caudata that is characterized by the absence of lungs. JPS respires through gills and permeable skin.

JPS found on the surface have well developed eyes, a wide head, and dark greenish brown body. Cave-dwelling salamanders can have reduced eyes, a flattened head, and loss of color (Chippendale *et al.* 2000). Chippendale suggests that there are two lineages, the taxonomic split corresponding to major geologic and topographic features. The “plateau” clade occupies Bull, Walnut, Shoal, Brushy, South Brushy, and southeast Lake Travis watersheds. The “peripheral” clade is found in the Buttercup and north Lake Travis watersheds.

The eggs of the JPS are rarely found on the surface, so it is likely that they are deposited underground (O’Donnell *et al.* 2005). The skin on the ventral side of the body is translucent so that eggs are visible. Some female JPS have been observed with eggs.

It appears from the presence of juveniles on the surface in all seasons that they reproduce year round (Bendik 2011, Hillis et al 2001). However, juvenile abundance often increases in the spring and summer suggesting higher reproduction in the winter and early spring (Bowles et a. 2006). At hatching, JPS are about 15 mm total length and reach reproductive maturity around 45-50 mm total length within six months to a year.

Their diet consists of small invertebrates, including fly larvae, ostracods, copepods, mayfly larvae, water mites, aquatic beetles, stonefly larvae, and snails (COA 2011). Underground, it is likely their diet is more restricted to stygobitic invertebrates like amphipods and isopods.

Predators of JPS may include centrarchid fish (sunfish and bass), crayfish, and large insects such as dragonfly nymphs and giant waterbugs (Bowles *et al.* 2006, Cole 1995).

The JPS inhabits groundwater-associated habitats, both surface and subsurface. On the surface, they can be found near spring outlets, along spring-fed streams, and in small hillside seeps. Underground, they inhabit the groundwater in the interstitial spaces and voids, subterranean streams, and wet caves. There are 106 known JPS surface sites in northwestern

Travis and southern Williamson Counties. Their range includes the following nine watersheds: Brushy, Bull, Buttercup, Cypress, Lake, Long Hollow, Shoal, Walnut, and West Bull.

The narrow distribution of JPS has been explained by certain habitat requirements, such as reliability of flow, minimal substrate siltation and calcium carbonate deposition (Tupa and Davis 1976, Sweet 1982), and availability of subsurface refugia (Dowling 1956, Rudolph 1978, Sweet 1982, Chippendale *et al.* 1993, Tumilson and Cline 1997). Another requirement for survival and reproduction is well oxygenated groundwater with a narrow temperature range (Davis *et al.* 2001, Bowles *et al.* 2006). Groundwater at the JPS sites flows from the Northern Segment of the Edwards Aquifer (Cole 1995), the Trinity Aquifer, and from local alluvial springs (Johns 2012).

In Travis County, most known JPS localities are found within the Bull Creek and Cypress Creek watersheds. The City of Austin, Travis County, and other cooperating agencies have established 13 long-term JPS population monitoring sites throughout Travis County. Most of the monitoring sites are located within the BCP.

Survey Sites & Locality Descriptions

Travis County Natural Resources staff regularly survey eight JPS locations (Figure 2). Four sites are monitored quarterly (since 2006): McDonald Well, SAS Upper and Lower Springs, and Kreschmarr Salamander Cave. Another four sites (R-Bar-B Spring, Concordia X and Y Springs, Kelly Hollow Spring) are searched annually and also during routine water quality monitoring visits.

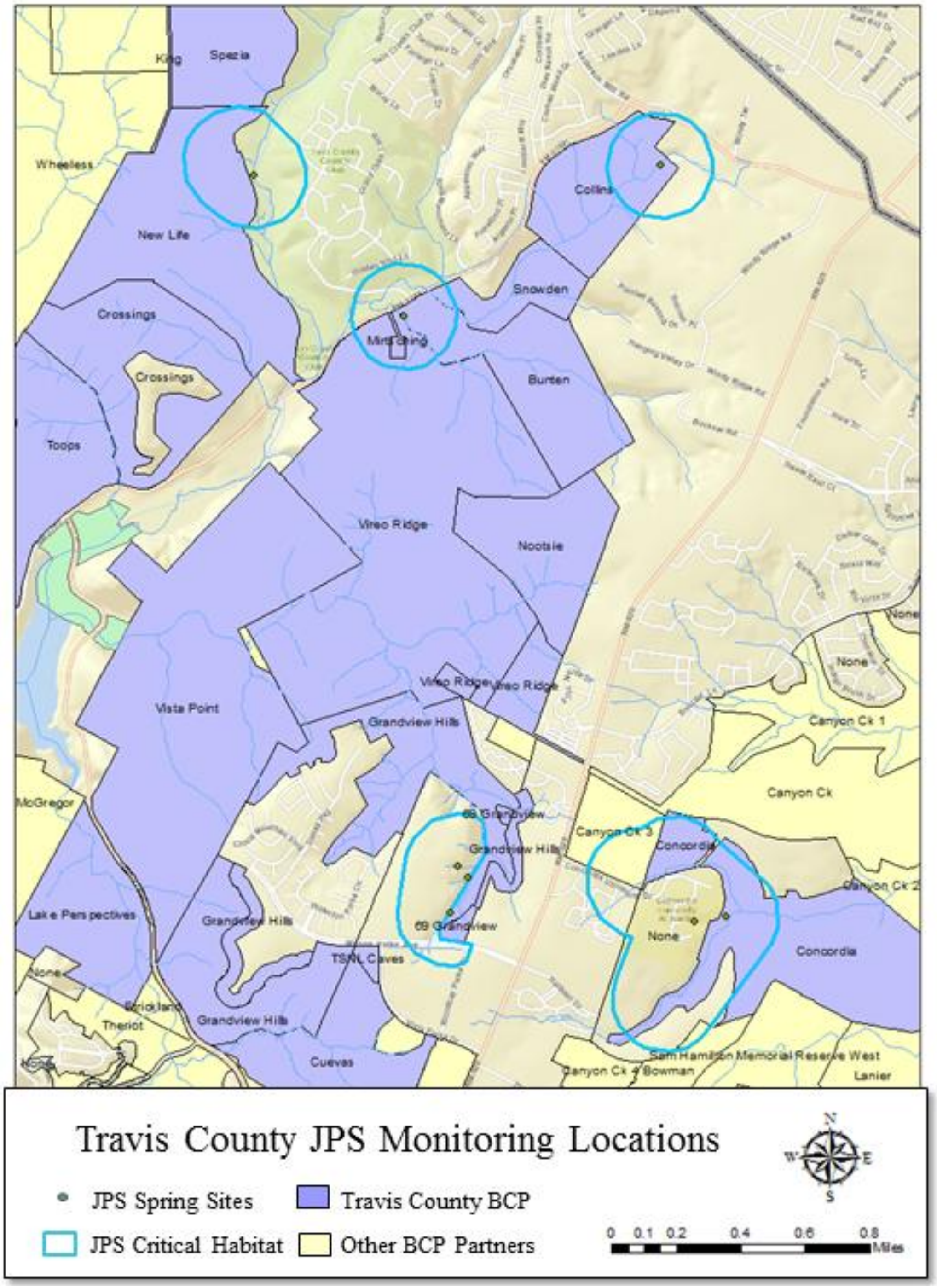
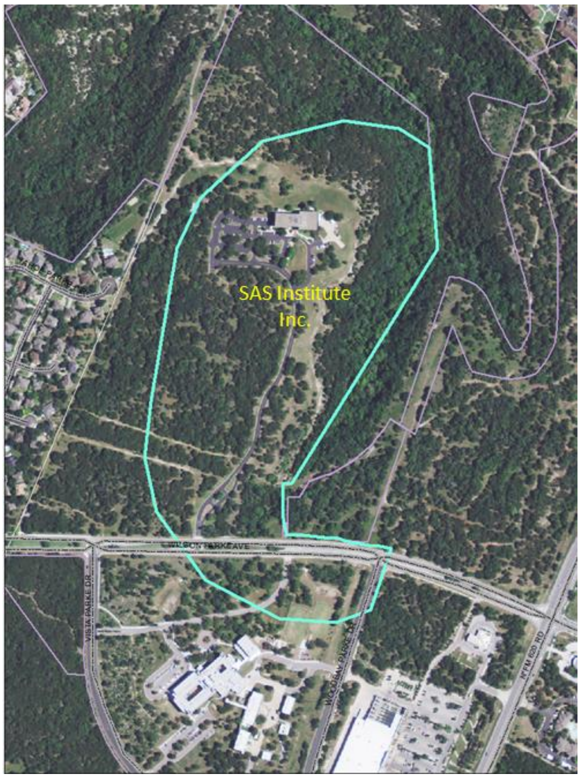


Figure 2. Eight locations where Travis County Natural Resources staff monitored the Jollyville Plateau salamander (*Eurycea tonkawae*) in FY13.

The SAS Canyon Springs (Upper and Lower) and Kretschmarr Salamander Cave sites are located on property owned by SAS Institute Inc., approximately 1 mile due north of the intersections of Highway 620 and FM 2222 (Figure 3). Travis County has an informal agreement with SAS Institute Inc. to access and monitor these JPS survey sites on a quarterly basis.

The springs at Concordia are in the Bull Creek watershed. JPS were located on the Concordia tract in the summer of 2008. Eight springs were confirmed, and three of the springs had JPS present. Of the three springs with JPS present, two are located on Travis County-managed preserve land and the other is located on Concordia University property that is not part of the preserve. The Concordia tract is 0.6 miles from the Concordia University Drive intersection with FM 620 (Figure 3).



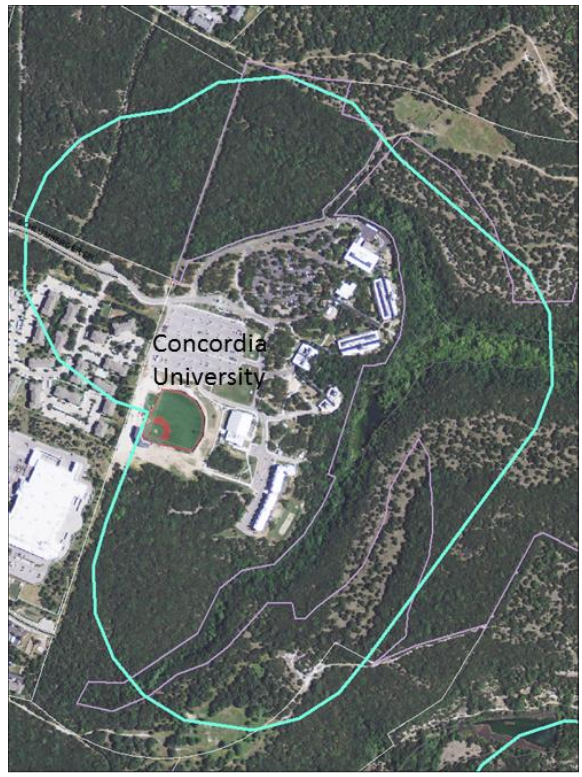


Figure 3. Map on the left shows Critical Habitat around the springs at SAS Canyon. The map on the right shows the Critical Habitat around JPS springs at Concordia.

McDonald Well spring discharges into an unnamed tributary approximately 500 m upstream of Cypress Creek. The BCP protects about half the critical habitat around this spring. It is located on Travis County BCP property called the Bunten tract, which is part of the larger 1,881-acre Jollyville Unit. McDonald well is located 13 miles northwest of downtown Austin near FM 2769 (Figure 4).

R-Bar-B spring is located in the Cypress Creek watershed on the New Life tract of the BCP. The 258-acre New Life tract, acquired by Travis County in 2010, is located off FM 2769 approximately 1.5 miles south of the intersection of Anderson Mill Road and FM 2769 (Figure 4). R-Bar-B Spring discharges 10 to 20 feet below the top of Glen Rose formation and forms the headwaters of Cypress Creek.

Figure 4. The map on the left shows the Critical Habitat around the JPS springs at R-bar-B. The map on the right shows Critical Habitat around the spring at McDonald Well.

Kelly Hollow Spring is located on Travis County BCP property called the Collins tract (Figure 5). The Collins tract (112.98 acres) is bounded by Anderson Mill Road to the north, private property to the east, FM 2769 to the west, and Travis County BCP property to the south. The spring discharges into an unnamed tributary that flows south approximately 2,500 m to its confluence with Cypress Creek.

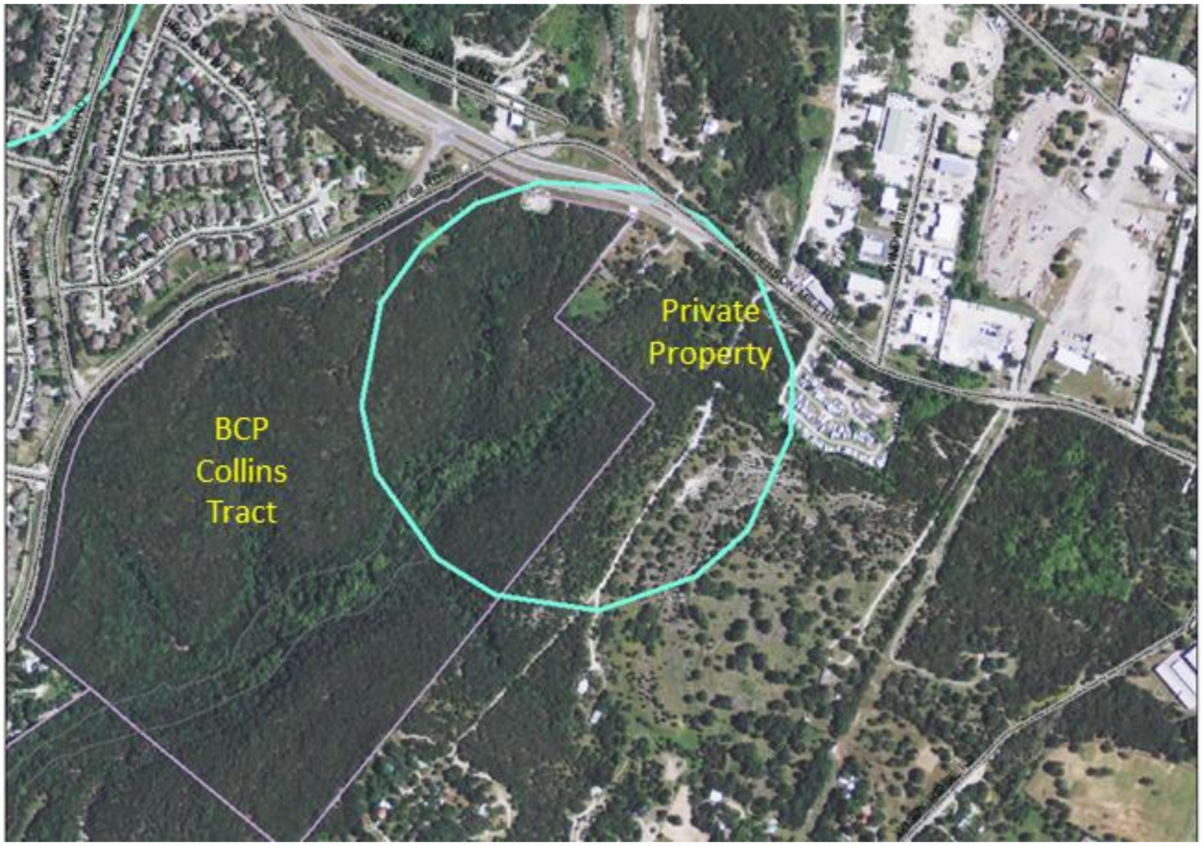


Figure 5. This photograph shows the Critical Habitat around Kelly Hollow Spring.

Methods

Two different survey methods are used by Travis County: surface counts (Davis *et al.* 2001) and mark-recapture using photographic identification (photo ID) (Bendik et al. 2013). Surface counts were used at all sites until 2011. In 2012, Travis County started a pilot project using the mark-recapture method at five survey locations: SAS Canyon Springs (Upper and Lower), Kretschmarr Salamander cave, McDonald Well, and R-bar-B Spring.

A surface count survey is conducted by searching under all cover objects on the surface of the stream (rocks, leaf litter, algae, woody debris, and aquatic macrophytes). Typically observers will start downstream and begin removing cover objects to create an open line perpendicular to the bank. Cover is searched moving upstream, counting only salamanders that move downstream of the observer (to avoid double-counts). Each salamander observed is recorded based on size class (Total length < one inch = small; one to two inches = medium; > two inches = large). Clear acrylic boxes are used to help reduce glare and view under water, especially in areas with turbulent flow. Surface counts are conducted under baseflow conditions (< one-half inch rainfall within the previous 24-hour period) to eliminate potential variable introduced by stormflow. The amount of search time is not constrained, but total search time is recorded for each site.

The search method is similar for a mark-recapture study, except salamanders are captured, photographed, and released. Individual salamanders are captured with aquarium nets. The most common technique is to place the top of the net flush to the stream bottom and gently guide the salamander to swim into the net. Occasionally, in areas with large amounts of leaf litter where detection is difficult, water and leaf litter is gently swept into a larger net (46 x 22 cm). Captured salamanders are immediately placed in flow-through mesh boxes near the collection site. Mesh boxes are placed every few meters along the springrun to ensure salamanders are released close to their initial point of capture.

To photograph individuals, each salamander is placed in a small transparent container with fresh spring water. The container is positioned over a 5 mm grid and dorsal side of the salamander is photographed (Figure 6). Immediately after being photographed, each salamander is returned to a mesh box in the springrun. An effort is made to minimize the amount of time each salamander is outside the springrun. After all salamanders have been photographed, they are released near their capture location.

Figure 6. JPS photographed in January 2012 at McDonald Well.

Another benefit of photo ID is that a slower, more controlled survey with fewer observers is possible. This type of survey has less impact on salamander habitat and less probability of unintended injury of the JPS from using large numbers of surveyors.

Also, some physical habitat, water quality, and flow data (where possible) are collected. In order to start monitoring water quality, Travis County staff began participating in the Colorado River Watch Network (CRWN) in 2011. CRWN is an environmental education and data collection program consisting of students, teachers, partnering organizations and citizen volunteers who regularly monitor the water quality along the lower Colorado River basin. CRWN's mission is to support community-based environmental stewardship by providing volunteers with the information, resources and training necessary to monitor and protect water quality. The Lower Colorado River Authority (LCRA) provides monitoring chemicals and supplies to monitor several sites on the BCP. Travis County follows the sampling and quality assurance protocols in the CRWN manual (Colorado River Watch Network 2013). The Area-Velocity method is used to collect flow measurements with an electronic flow meter.

Field data and all photographs are retained in digital files. Photographs are used to measure the size of each salamander using ImageJ software (Rasband 1997) and to match to JPS previously captured and photographed using Wild-ID software.

JPS surveys were scheduled (four sites quarterly and four sites annually) when surface flow allowed. This report reflects surveys completed during FY13.

FY13 Jollyville Plateau Salamander Surveys

<u>Upper SAS Spring</u>

The upper spring pool in SAS Canyon Spring was surveyed on October 12, 2012, January 31, 2013, and May 29, 2013 (Table 1). Another survey was scheduled for August 30, 2013, but flow had ceased and there was only a small pool of surface water. No JPS were observed on that day.

Table 1. Upper SAS Canyon Spring Jollyville Plateau salamander (*Eurycea tonkawae*) survey results for FY13.

FY11	10/12/2012	1/31/2013	5/29/2013	8/30/2013	Total by size class
Small juvenile <1inch	0	0	1	0	1
Large juvenile 1 to 2 inches	2	2	9	0	13
Adult >2 inches	1	5	8	0	14
Total by date	**3**	**7**	**18**	**0**	**28**

October 12, 2012

Three JPS (one adult and two large juveniles) were observed at the upper spring in SAS Canyon. Two JPS, one adult and one large juvenile, were photographed. The following water quality data were collected: dissolved oxygen was 3.55 mg/L, water temperature 21.5°C, specific conductance 700 µS/cm, and pH 7.0. No flow measurement was possible (spring pool with no surface flow downstream).

Figure 7. Upper SAS spring outlet (right) and downstream (left) on October 12, 2013.

January 31, 2013

Seven JPS, five adults and two large juveniles, were found at the upper spring in January. Three (two adults and one large juvenile) were photographed. The following water quality data were collected: dissolved oxygen was 5.8 mg/L, water temperature 18.5°C, specific conductance 660 µS/cm, CO_2 40 mg/L, nitrate–nitrogen 1.0 mg/L, and pH 7.25. No flow measurement was possible (spring pool with no surface flow downstream).

Figure 8. Upper SAS spring outlet (right) and downstream (left) on January 31, 2013.

May 29, 2013

Eighteen JPS were detected at the upper spring, which included eight adults, nine large juveniles, and one small juvenile. Eleven JPS (six adults and five large juveniles) were photographed. The following water quality data were collected: dissolved oxygen 5.25 mg/L, water temperature 20.5°C, specific conductance 590 µS/cm, CO_2 40 mg/L, nitrate–nitrogen less than 1.0 mg/L, and pH 7.25. No flow measurement was possible (spring pool with no surface flow downstream).

Figure 9. Upper SAS spring outlet (right) and downstream (left) on May 29, 2013.

Figure 10. Summary of JPS survey data and select water quality data collected at Upper SAS Spring during FY13. Precipitation from GHCND:US1TXTV0145 - AUSTIN 12.7 NNW, TX US. Nitrate-N recorded as equal to/or less than in mg/L.

Lower SAS Spring

The lower spring pool in SAS Canyon was surveyed for JPS on October 13, 2012, January 31, May 17, and August 30, 2013. No JPS were detected on any of these surveys.

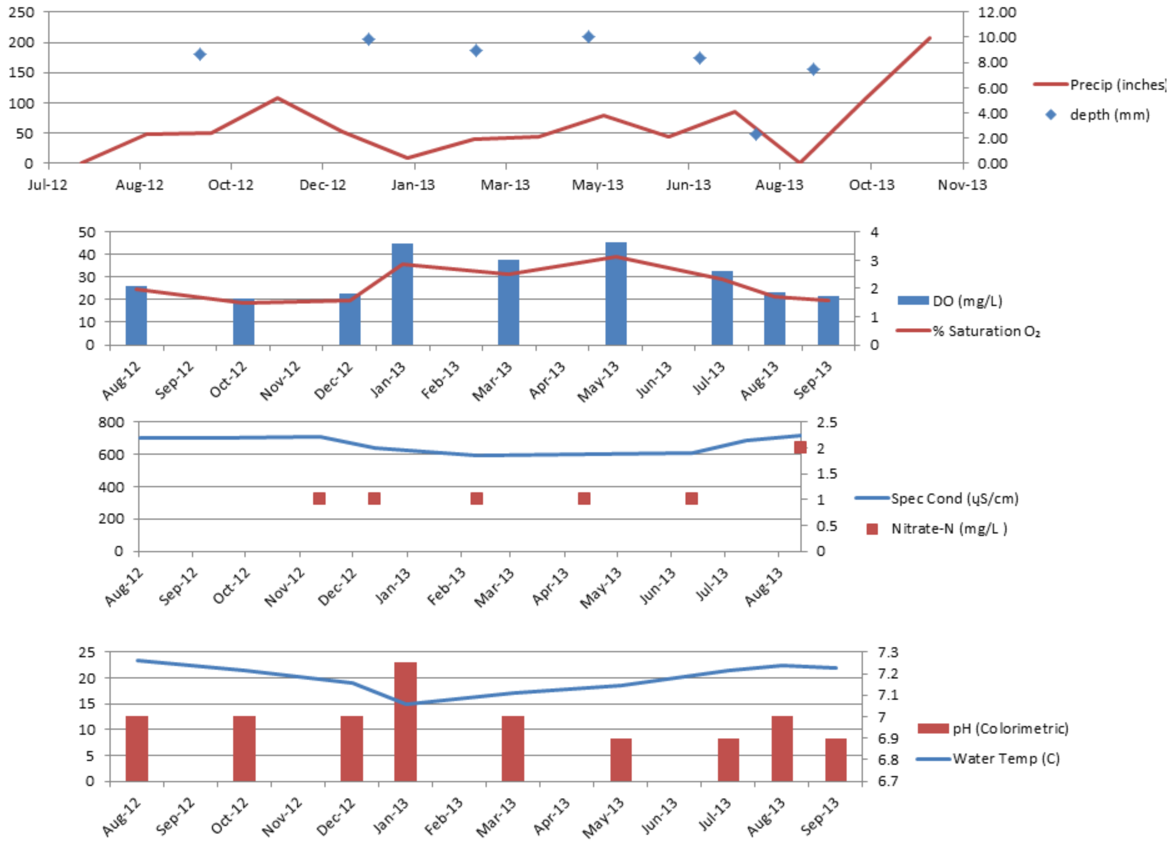


Figure 11. Summary of JPS survey data and select water quality data collected at Lower SAS Spring during FY13. Precipitation from GHCND:US1TXTV0145 - AUSTIN 12.7 NNW, TX US. Nitrate-N recorded as equal to/or less than in mg/L.

Kretschmarr Salamander Cave Spring

No surveys were conducted during the first quarter because the cave was flooded and staff could not enter safely (Figure 12). The water began receding in November (2-inches below the cave gate) and was safe to enter again in January 2013. Surveys were conducted January 31, May 20, and August 30, 2013 (Table 2).

First Quarter of FY13

Figure 12. Kretschmarr Salamander Cave was flooded half-way up the gate during the first quarter of FY13.

Table 2. FY13 Jollyville Plateau salamander (*Eurycea tonkawae*) survey results for the spring inside Kretschmarr Salamander Cave spring.

FY11	10/11/2012	1/31/2013	5/20/2013	8/30/2013	Total by size class
Small juvenile <1inch	NA	0	0	0	0
Large juvenile 1 to 2 inches	NA	2	0	1	3
Adult >2 inches	NA	11	11	2	24
Total by date	**NA**	**13**	**11**	**3**	**27**

January 31, 2013

In January, thirteen JPS were observed, eleven adults and two large juveniles. Eleven adult JPS were photographed. The following water quality data were collected: dissolved oxygen was 7.0 mg/L, water temperature 20.5°C, specific conductance 910 µS/cm, CO_2 70 mg/L, nitrate–nitrogen 2.0 mg/L, and pH 7.25.

Figure 13. This photograph is looking upstream at the spring inside Kretschmarr Salamander Cave on January 31, 2013.

May 20, 2013

In May, eleven JPS were observed and photographed, all adults. The following water quality data were collected: dissolved oxygen was 6.3 mg/L, water temperature 20.5°C, specific conductance 1000 µS/cm, nitrate–nitrogen 1.0 mg/L, and pH was 6.9. Flow was estimated with electronic flow meter at nine stations to be 0.02 cfs.

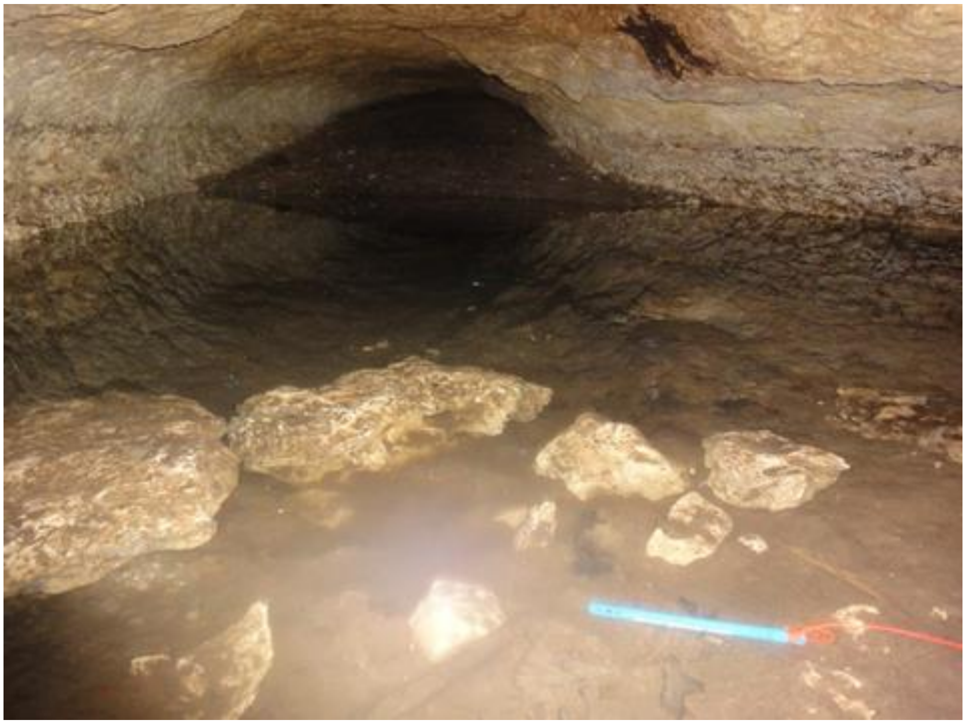


Figure 14. This photograph is looking upstream at the spring inside Kretschmarr Salamander Cave on May 20, 2013.

August 30, 2013

In August, three JPS (two adults and one large juvenile) were observed. One adult was photographed. Flow had decreased and water levels inside the cave were rising. This combination made survey activities difficult due to limitations on movement inside the restricted space and poor water clarity caused by the low flow. The following water quality data were collected: dissolved oxygen was 5.7 mg/L, water temperature 21.0°C, specific conductance 930 µS/cm, CO_2 45 mg/L, and pH was 7.2. Flow was estimated with electronic flow meter at seven stations to be 0.01 cfs.

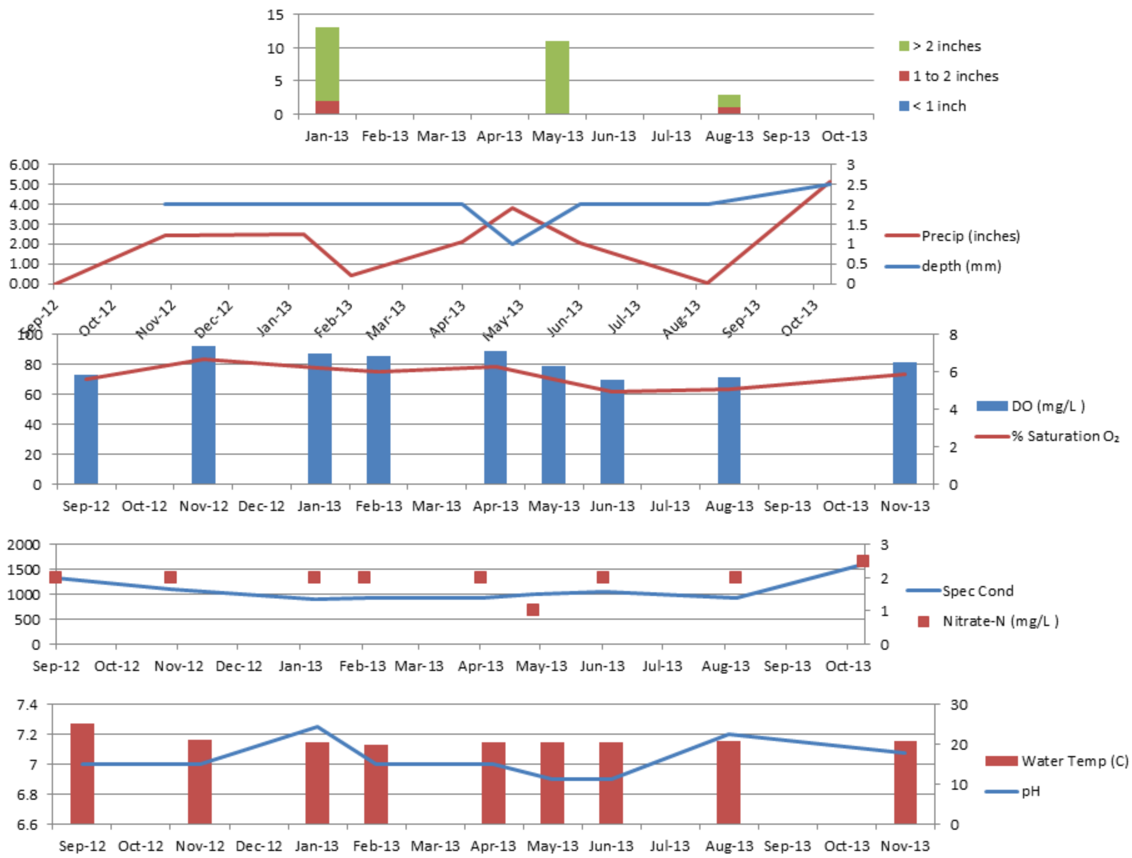


Figure 15. Summary of JPS survey data and select water quality data collected at Kretschmarr Salamander Cave during FY13. Precipitation from GHCND:US1TXTV0145 - AUSTIN 12.7 NNW, TX US. Nitrate-N recorded as equal to/or less than in mg/L.

<u>McDonald Spring</u>

McDonald Spring was surveyed four times during FY13 on October 11, 2012, January 17, June 4, and July 24, 2013 (Table 3). Surveys were scheduled around periods of flow. In FY13, McDonald Spring flowed from September 28 to October 11, 2012, January 5 to April 24, 2013, May 31 to June 10, 2013, July 15 to August 5, 2013, October 15 to November, 2013 (at the time of this report).

Table 3. McDonald Spring Jollyville Plateau salamander (*Eurycea tonkawae*) survey results for FY13.

FY11	10/11/2012	1/17/2013	6/4/2013	7/24/2013	Total by size class
Small juvenile <1inch	0	2	0	1	3
Large juvenile 1 to 2 inches	2	27	0	6	35
Adult >2 inches	1	96	17	19	133
Total by date	**3**	**125**	**17**	**26**	**171**

October 11, 2012

The spring was flowing on October 9, 2012, two days before the survey. On the survey date no surface flow was observed. The remaining pools were searched for JPS. Three individuals (one adult and two large juveniles) were observed during the survey at McDonald Spring in Fall 2012. Two JPS were photographed (one adult and one large juvenile). The following water quality data were collected: dissolved oxygen was 2.9 mg/L, water temperature 21.0°C, specific conductance 790 µS/cm, and pH was 7.0. It was not possible to measure discharge due to a lack of surface flow.

Figure 16. Stream pools that were searched for the JPS after McDonald Well had stopped flowing on October 11, 2012.

January 17, 2013

McDonald Spring started flowing again on January 5, 2013. There was approximately 3.3 inches of rainfall during the previous month (LCRA Cedar Park 3 SSW gauge). McDonald

Spring was surveyed in January after it had been flowing for twelve days. One hundred twenty-five individuals (ninety-six adults, twenty-seven large juveniles, and two small juveniles) were observed. Forty-four JPS were photographed (thirty-five adults, eight large juveniles, one small juvenile). This survey was the first time most Travis County staff had attempted to capture JPS, so the capture rate was low (35%). The survey may have also been affected by filamentous algae, which covered approximately 30% of the surface. The following water quality data were collected: dissolved oxygen was 6.05 mg/L, water temperature 18.5°C, specific conductance 750 µS/cm, nitrate–nitrogen less than 2.0 mg/L, and pH was 7.5. Flow was estimated with an electronic flow meter to be 0.21 cfs. This estimate includes flow from another spring to the southwest. The spring continued to flow on the surface for about three more months.

Figure 17. Top photographs of (from left to right) show McDonald Well spring outlet and upstream from the spring on January 17, 2013. Both bottom photographs show the downstream habitat.

June 4, 2013

McDonald started flowing again on May 31, 2013 after approximately 3.9 inches (LCRA Cedar Park 3 SSW gauge) of rain the previous month. Seventeen adult JPS were detected in the June survey (15 photographed; all > 2 inches). The following water quality data were collected: dissolved oxygen was 4.1 mg/L, water temperature 20.0°C, specific conductance 720 µS/cm, nitrate–nitrogen 2.0 mg/L, and pH was 7.1. Flow was estimated with an electronic flow meter to be 0.79 cfs. This estimate includes flow from another spring to the southwest. After eleven days, the spring stopped flowing on the surface (June 10, 2013).

Figure 18. McDonald Well spring outlet (left) and downstream habitat (right) on June 4, 2013.

July 24, 2013

McDonald started flowing again on July 15, 2013 after 1.22 inches (LCRA Cedar Park 3 SSW gauge) of rain in the previous month. Twenty-six JPS (nineteen adults, six large juveniles, and one small juvenile) were detected in the July survey, which occurred nine days after surface flow appeared. Twenty-four JPS were photographed (eighteen adults, five large juveniles, and one small juvenile). The following water quality data were collected: dissolved oxygen was 4.1 mg/L, water temperature 20.0°C, specific conductance 720 µS/cm, nitrate–nitrogen 2.0 mg/L, and pH was 7.1. Flow was estimated with an electronic flow meter 0.025 cfs. This estimate includes flow from another spring to the southwest. McDonald spring flowed for another 21 days, until August 5, 2013.

Figure 19. McDonald Well spring outlet (left) and downstream habitat (right) on July 24, 2013.

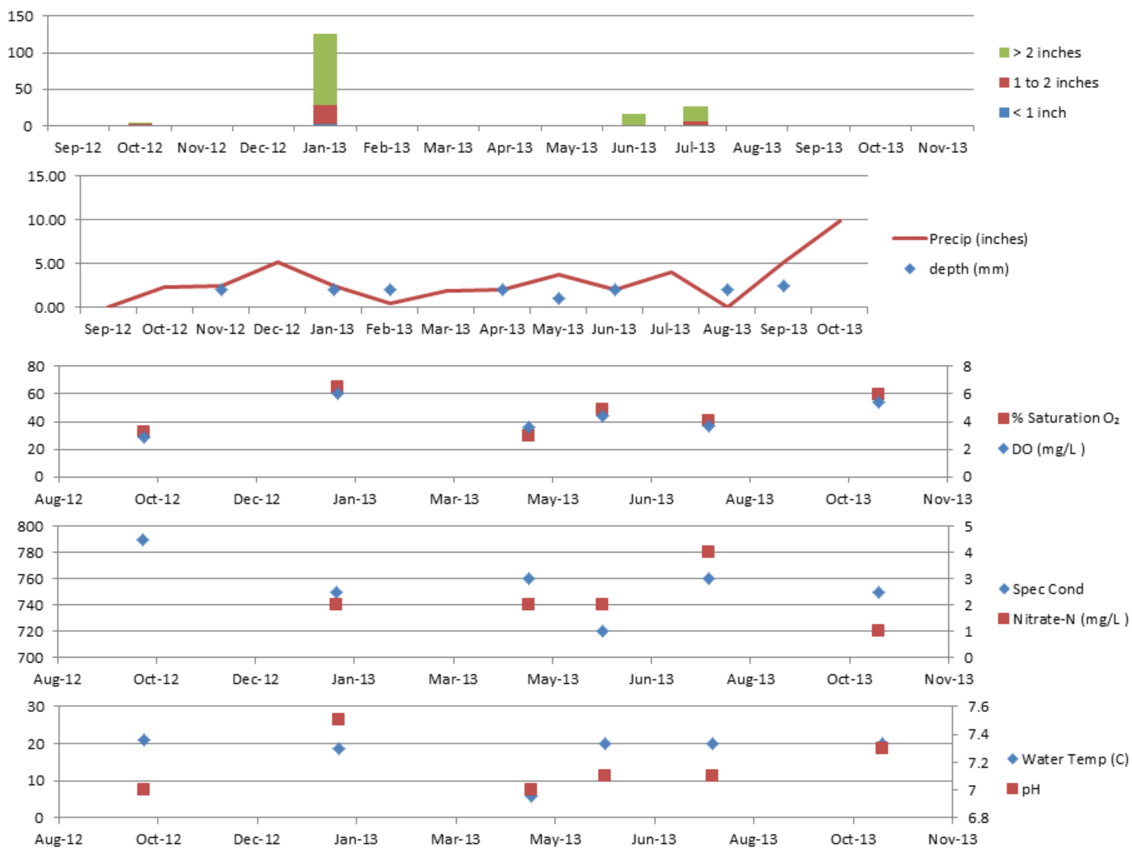


Figure 20. Summary of JPS survey data and select water quality data collected at McDonald Well during FY13. Precipitation from GHCND:US1TXTV0145 - AUSTIN 12.7 NNW, TX US. Nitrate-N recorded as equal to/or less than in mg/L.

R-Bar-B Ranch Spring

R-Bar-B Ranch Spring was surveyed one time during FY13 on September 4, 2013 (Table 4).

Table 4. R-Bar-B Spring Jollyville Plateau salamander (*Eurycea tonkawae*) survey results for September 5, 2013 on Travis County Balcones Canyonlands Preserve.

FY11	9/5/2013
Small juvenile <1inch	0
Large juvenile 1 to 2 inches	8
Adult >2 inches	9
Total by date	**17**

Seventeen individuals, nine adults and eight large juveniles, were observed during the survey at R-Bar-B Ranch Spring in September. Fourteen (eight adults and six large juveniles) were photographed. The following water quality data were collected: dissolved oxygen was 5.8 mg/L, water temperature 21.5°C, specific conductance, CO_2 35 mg/L, 740 µS/cm, nitrate–nitrogen less than 2.0 mg/L, and pH was 7.1. Flow was estimated with electronic flow meter at twelve stations to be 0.014 cfs.

Figure 21. The top two photographs show the springs at the headwaters of R-bar-B on September 4, 2013. The bottom two photographs show downstream habitats on the survey date.

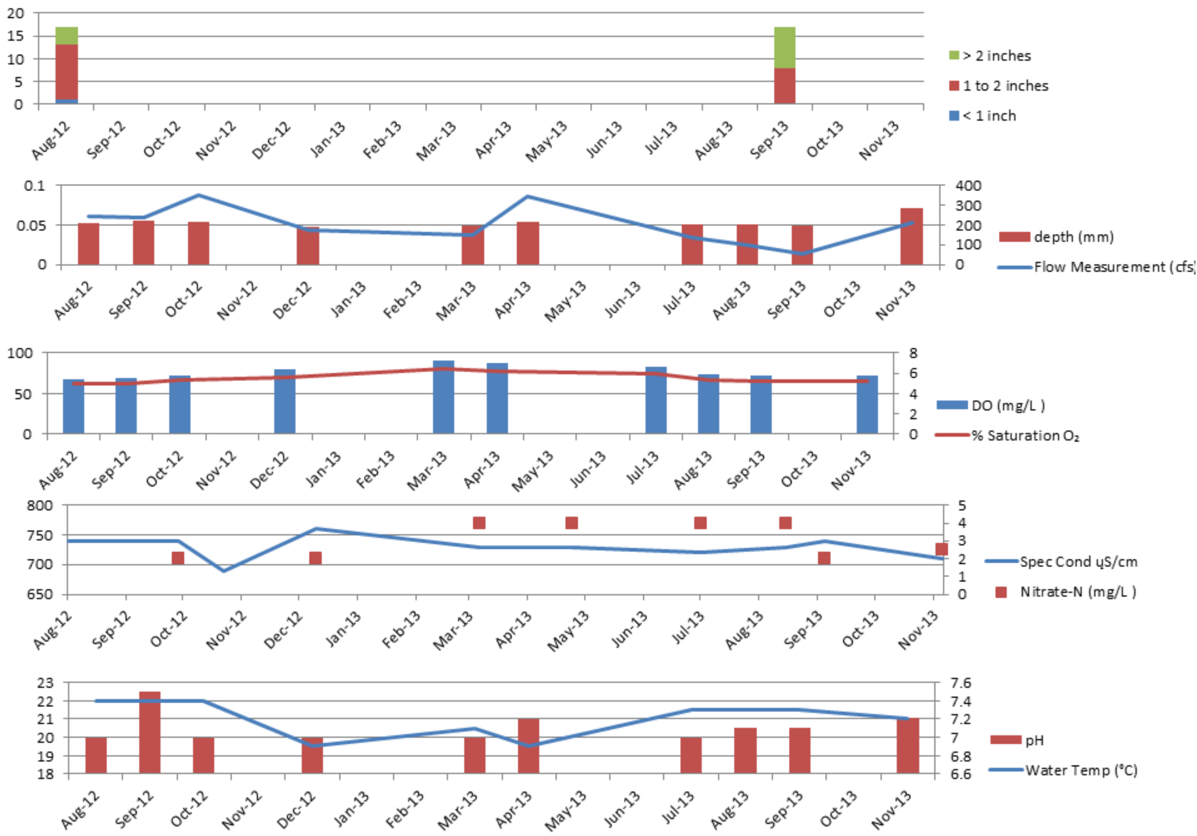


Figure 22. Summary of JPS survey data and select water quality data collected at R-bar-B Spring during FY13. Precipitation from GHCND:US1TXTV0145 - AUSTIN 12.7 NNW, TX US. Nitrate-N recorded as equal to/or less than in mg/L.

<u>Concordia Springs</u>

Concordia Spring X and Y were searched for JPS with help from Concordia students on March 12, 2013 and by a single observer during water quality monitoring. Only one JPS (1 to 2 inches) was observed at Spring X on October 7, 2013.

Figure 23. Concordia Spring X (left) and Y (right) during FY13.

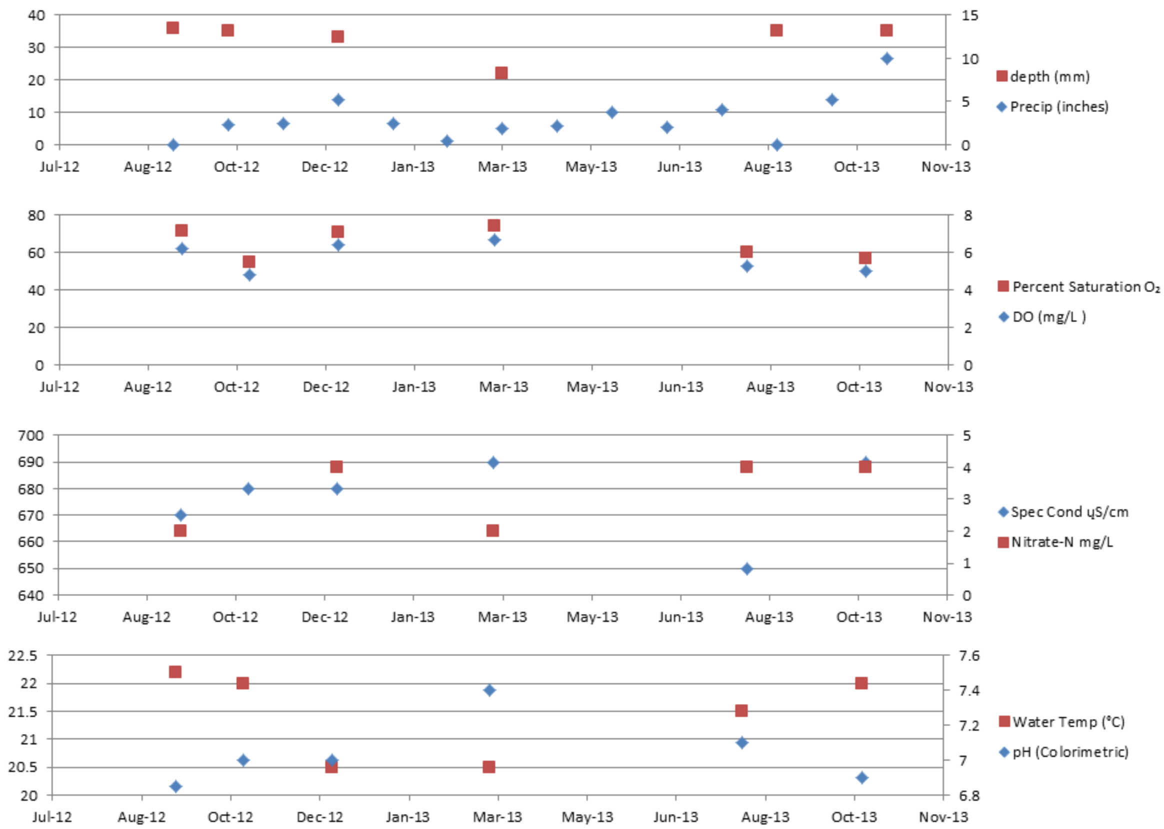


Figure 24. Summary of JPS survey data and select water quality data collected at Concordia Spring X during FY13. Precipitation from GHCND:US1TXTV0145 - AUSTIN 12.7 NNW, TX US. Nitrate-N recorded as equal to/or less than in mg/L.

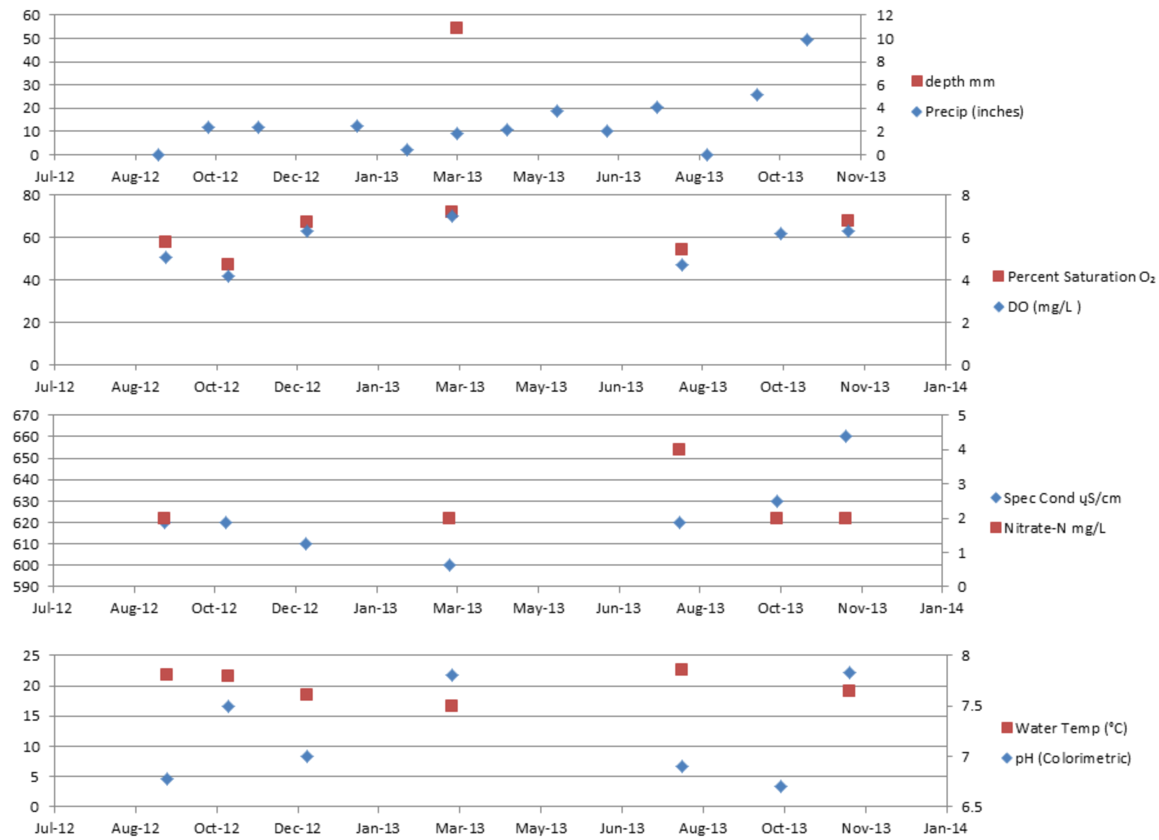


Figure 25. Summary of JPS survey data and select water quality data collected at Concordia Spring Y during FY13. Precipitation from GHCND:US1TXTV0145 - AUSTIN 12.7 NNW, TX US. Nitrate-N recorded as equal to/or less than in mg/L.

<u>Kelly Hollow Spring</u>

Kelly Hollow Spring was searched for JPS on the following dates during FY13: December 3, 2012, March 4, 2013, May 15, 2013, and September 17, 2013 (Table 5). Two JPS, one adult and one large juvenile, were observed during FY13.

Table 5. Kelly Hollow Spring Jollyville Plateau salamander (*Eurycea tonkawae*) survey results for FY13.

FY13	12/3/2012	3/4/2013	5/15/2013	9/17/2013	Total by size class
Small juvenile <1inch	0	0	0	0	0
Large juvenile 1 to 2 inches	0	1	0	0	1
Adult >2 inches	0	0	0	1	1
Total by date	**0**	**1**	**0**	**1**	**2**

Figure 26. The top two and bottom left photographs show the spring outlet at Kelly Hollow (yellow arrow indicates flow out of the spring outlet). The bottom right photograph shows the springrun (yellow arrow shows direction of flow downhill). The photograph was taken near where the springrun flows into the tributary to Cypress Creek.

Figure 27. Summary of JPS survey data and select water quality data collected at Kelly Hollow Spring during FY13. Blue stars indicate an observation of the JPS. Precipitation from GHCND:US1TXTV0145 - AUSTIN 12.7 NNW, TX US. Nitrate-N recorded as equal to/or less than in mg/L.

Site	Total Number of JPS	% Saturation O_2	Water Temp (°C)	DO (mg/L)	Spec Cond (µS/cm)	pH	Nitrate (mg/L)
Upper SAS	7 (8)	42.9 (19.5)	20.6 (1.5)	4.5 (0.9)	670.0 (46.1)	7.0 (0.1)	1.2 (0.4)
Lower SAS	0.0	26.9 (7.3)	19.6 (2.9)	2.5 (0.8)	660.0 (49.4)	7.0 (0.1)	1.1 (0.4)
Kretschmarr Salamander Cave	9 (5)	72.7 (7.0)	21.2 (1.5)	6.5 (0.7)	1086.7 (233.1)	7.0 (0.1)	1.9 (0.4)
McDonald Well	43 (56)	45.9 (14.3)	17.6 (5.7)	4.3 (1.2)	755.0 (22.6)	7.2 (0.2)	2.2 (1.1)
R-bar-B Spring	17.0	68.9 (6.3)	21.1 (1.0)	6.2 (0.6)	729.0 (19.1)	7.1 (0.2)	3.1 (1.0)
Concordia Spring X	1.0	65.5 (8.0)	21.5 (0.7)	5.8 (0.8)	680.0 (16.3)	7.1 (0.2)	3.1 (1.0)
Concordia Spring Y	0.0	62.1 (9.1)	19.8 (2.2)	5.8 (1.0)	627.5 (21.9)	7.3 (0.5)	2.3 (0.8)
Kelly Hollow	2.0	49.9 (8.6)	20.4 (0.4)	4.5 (0.8)	778.6 (59.3)	7.1 (0.2)	1.5 (0.6)

Table 6. Average (and standard deviation) of total JPS and select water quality parameters for FY13. Nitrate –N measured as equal to/or less than mg/L.

Scientific Research Permits

In FY13, three scientists from the City of Austin Watershed Protection Department conducted research related to JPS on TC-managed BCP lands. Travis County Natural Resources issued three Scientific Research Permits (SRP) for this research: #18-2013, #20-2013, and #22-2013.

SRP#18-2013 was issued to David Johns, Senior Environmental Scientist with the City, to conduct dye tracing in the vicinity of a proposed tunnel access shaft in the Four Points area and water transmission tunnel traversing the BCP Sam Hamilton Memorial Reserve and the Bull Creek Preserve. The purpose of this project is to determine the direction of groundwater movement, approximate flow velocities, and to determine which springs are in the flow path (See Appendix P-10).

SRP #20-2013 was issued to Nathan Bendik, an Environmental Scientist with the City, for a Mark-Recapture study of JPS. The study objectives are to collect information about the life history and population dynamics of JPS. This information includes individual growth rates, population size trends, survival, and temporary emigration estimates. This information will be used to better understand the ecology of the species and how this species responds to environmental fluctuations (See Appendix P-3).

SRP #22-2013 was issued to Thais Perkins, Project Coordinator for the Jollyville Transmission Main (JVTM) and Water Treatment Plant 4 (WTP4). Monitoring is proposed for the Bull Creek watershed to determine effects, if any, of shaft construction and tunneling associated with the construction of the JVTM and WTP4. One monitoring site, called Ribelin Spring 2, is located on Travis County's Sam Hamilton Memorial East tract. Monitoring at Ribelin Spring 2 includes collecting water quality samples and flow measurements (See Appendix P-14).

Threats

Amphibians are sensitive indicators of environmental degradation (Berindaga 1990). Amphibians with restricted ranges, in or near expanding metro areas, face great risk of extinction. Of the thirteen *Eurycea* salamanders in central Texas, seven are threatened by or completely surrounded by development. Most known localities are at risk from urbanization due to their localized recharge areas. (Chippendale *et al.* 2000, Chippendale and Price 2005, USFWS 2012). Prior research has shown that salamander densities are reduced in urbanized stream catchments (Oser and Shure 1972, Willson and Dorcas 2003). Urbanization can cause changes to natural flow regime and degradation of surface and groundwater. These changes to habitat quality may be the largest threat facing the JPS and must be considered in conservation efforts (Bowles *et al.* 2006).

The City of Austin's population has grown 192% from 1970 to 2007 (COA 2007). Bowles *et al.* (2006) found lower JPS density in developed tributaries compared to springs in undeveloped watersheds. Developed tributaries had higher concentrations of chloride, magnesium, nitrate-nitrogen, potassium, sodium, and sulfate (Bowles *et al.* 2006). Four of nine JPS sites monitored by the City of Austin from 1996 to 2007 showed statistically significant declines in salamander abundance over ten years (O'Donnell *et al.* 2006). Analysis of count data from 1996 to 2011 reveal that JPS populations declined in areas with the largest increases in residential development over a 15-year period and furthermore, that densities of the JPS are negatively correlated with residential development across its range (Bendik *in press*).

Future Conservation Efforts

To address the conservation of the JPS, Travis County will continue manage and acquire land to protect endangered species, which will benefit this species and water quality. All springs within Travis County BCP tracts will be protected and if found to host JPS, will be managed to protect this species. Travis County will also collaborate in research efforts to elucidate many of the unknowns in regard to JPS life history, habitat preferences, potential threats, and the mechanics of the northern segment of the Edwards Aquifer. Also, Travis County will continue to contribute long-term monitoring by performing regular JPS surveys and water quality monitoring at JPS sites and other BCP sites where appropriate. Staff will explore other preserve springs, creeks, and tributaries for populations of JPS and document any discoveries in annual reports submitted to USFWS. After discovery of additional populations, staff will return on a regular basis to verify JPS presence at these sites.

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